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THE INFLUENCEOF SASOBITON THE PERFORMANCE OF BITUMEN AND ASPHALTIC CONCRETE

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***ABSTRACT**: The study assessed the influence of Sasobit polymer on the characteristic properties of bitumen and asphaltic concrete. Sasobit® modified bitumen was prepared by adding Sasobit® to bitumen with increasing weight of Sasobit® at 1.0, 1.5, 2.0, 2.5 and 3 % by the weight of the bitumen. Penetration and softening point tests were carried out on the samples and the mix-ratio for the mixture of bitumen and sasobit was determined. Then asphaltic concrete samples with and without Sasobit® were prepared. Stability test, Flow test, specific density test, voids filled with bitumen (VFB), voids in the mineral aggregate (VMA), and air voids (VA) were all determined with the aid of Marshal Apparatus. The study found the following values of bitumen with sasobit and bitumen without sasobit to be; stability was 14.72, flow was 2.51, specific density was 2.58, voids filled with bitumen was 73.80, air voids was 3.99 and voids filled in the mineral aggregates was 16.52 for sample without Sasobit® were 13.83kN 2.97 mm, specific density was 2.53, voids filled with bitumen was 64.87 %, air voids was 4.34 % and voids filled with mineral aggregates was found to be 18.26 %, respectively. The study concluded based on the result obtained that, Sasobit® as an additive in asphaltic concrete has the potentials to improve its properties.*

***KEYWORDS**: Sasobit, Marshal Apparatus, Bitumen, Asphaltic Concrete, Performance, Influence*

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I. INTRODUCTION

Nigeria has over 200,00 km of roads network across the federation, The Federal Government owns over 32,000 km of them in the thirty six states and the Federal Capital Territory Abuja, the state governments own more than 30,000 and over 130,000 km are owned by the Local Governments. Majority of these roads are in very poor conditions due to rutting and fatigue cracking distresses (Ndefo, 2012).

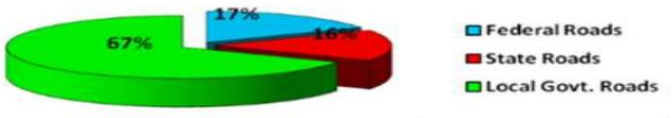

Fig. 1. Ownership structure of Nigeria Roads Network (FERMA, 2013a).

People are faced with delays due to traffic congestion, and accidents claiming the lives of bread winners of many homes.

Stresses and strains on asphalt concrete cause distresses to propagate, and they are due to increased vehicular loading and temperature changes. The formation of stresses is a function of the performance of asphalt mixture, meaning that if the asphalt mixture is performing well, it takes a much longer time for the distresses to form and expand. It is an established fact that the behaviour of asphalt mixture is highly related to the characteristic properties of bitumen (Tasdemir 2009). If bitumen is not so viscous, the penetration grade will be high and this can offer resistance to crackingat low temperatures, but susceptible to rutting defect at high temperatures. The opposite is the case in hard bitumen with low penetration grade; although it performs well at high temperatures, it doesn't have much resistance to cracking when compared with softer bitumen (Tasdemir, 2009, Zhang et al, 2009). The reason lies in the fact that the rheological behaviour of bitumen is complicated, in that it is capable of exhibiting viscous, elastic or viscoelastic characteristicsat different environmental conditions (Airey 2004; Isaacsson, Lu 1999).

The viscoelastic characteristics of asphalt concrete is due to environmental conditions; when the temperature is high or low, it will show elastic or viscous behaviour. When the temperatures is high, the viscosity of bitumen becomes low, at this point asphalt concretes is susceptible to bleeding and rutting. On the other hand, at very low temperatures, bitumen becomes hard, at this point asphalt concrete's resistance to cracking is low.

So, that is why researchers are thinking of ways to tamper with the characteristics of neat bitumen, by adding additives to it, in order to address temperature changes. For this, modification of bitumen is one of the most acceptable ways to improve asphalt mixture characteristics. This study is evaluating the influence Sasobit Polymer will have on the behaviour of bitumen and asphalt concrete.

Sasobit is long chain aliphatic hydrocarbon (chain lengths of 40-115 carbon atoms), obtained from coal gasification using Fischer-Tropsch process. At temperatures below the melting point, it forms a crystalline network structure in the binder which is reported to provide added stability for the bitumen (Lee et al. 2008).

Sasobit forms a homogenous solution with the base bitumen during the stirring process and cause the viscosity of bitumen to reduce. After crystallization, Sasobit forms a lattice structure in the bitumen, that is what makes bitumen blended with Sasobit to be structurally stable. The recommended addition rate is 0.80-3.0% by weight of the bitumen (Hurley et al. 2005, 2006).

Addition of Sasobit to bitumen has the potential to reduce the thickness of bitumen which can also lead to lower mixture and compaction temperatures. When the void content is reduced by proper compaction, the mixture's resistance to rutting is significantly improved upon (Sanchez-Alonso 2011a).

A. STATEMENT OF THE PROBLEM

Fatigue cracking and rutting are the two main failure distresses in flexible pavements that can affect its serviceability or lifespan significantly. Bitumen is a viscoelastic material, which softens fairly quickly at high temperatures and under slow moving loads. Under this condition, the material becomes susceptible or liable to permanent deformation (rutting).This phenomenon is very common on Nigerian roads due to high temperatures, increase in vehicular loading and repetitions.

Because the characteristics of bitumen can cause formation and expansion of fatigue cracking and permanent deformation. Modification of neat bitumen has become a necessity in Nigeria, hence it is capable of improving its mechanical properties.

B. MAJOR RESEARCH FINDINGS

Generally, based on the results obtained, Sasobit Polymer has the potential to enhance the mechanical characteristics of bitumen and asphalt concrete when used as an additive or modifier, and that the addition of Sasobit to bitumen has the potential to lower the penetration grade and cause bitumen to be softer.

II. MATERIALS AND METHODS

Sasobit® and bitumen were bought from the International building materials market at Dei-Dei, Abuja, Coarse aggregate was procured from Avookee Quarry located at Jimgbe, Lokoja and Fine aggregate (river sand) was also collected at Lokoja. Grading, specific gravity and water absorption tests were conducted on the aggregates, while specific gravity, penetration and softening point tests were done for the bitumen using standard procedures. Sasobit® modified bitumen was prepared by adding Sasobit® to bitumen with increasing weight of Sasobit® at 0%, 1%, 1.5%, 2.0%, 2.5%, 3.0%,by weight of the bitumen. Penetration and softening point tests were carried out on the samples and the mix-ratio for the bitumen – polymer mixture was determined (Sasol Wax Company, 2004). The optimum value of the binder used for the study was determined from the mix design (Garber and Hoel, 2015). Asphaltic concrete samples with and without Sasobit® were prepared. Stability, flow, specific density, voids filled with bitumen (VFB), air voids (VA) and voids in the mineral aggregate (VMA) were determined using standard procedures of the Marshal apparatus.

III. RESULTS AND DISCUSSIONS

The aggregate grading curve (Fig. 1) shows that the grading falls within the grading envelope of the General Specifications (Roads and Bridges) (Fig. 1). The specific gravity was 2.53 and Water absorption factor was 0.46 %, implying that the materials were suitable for use in the asphaltic concrete in accordance to the Federal Ministry of Works and Housing (1997).

The values of the specific gravity, penetration and softening tests for the bitumen were 2.53, 64 mm and 47°C respectively. These values satisfy the requirement that bitumen could be used for asphaltic concrete production as specified in Clause 6371, Table VI-15, FMWH, 1997.

Table 1shows the result of the penetration and softening point tests for the sasobit-bitumen mixture, and the graph of Sasobit®, penetration and softening tests was plotted in Fig. 2.

Table 1 clearly showed that the penetration values decreased as the Sasobit polymer was increased. Which implied a more viscous and harder mix, meaning that a stiffer asphaltic concrete would be obtained (Hainin et al., 2014). And this could offer more resistance against permanent deformation during the lifespan of the asphalt concrete pavement blended with Sasobit® polymer as a modifier in bitumen.

The results of softening point test clearly shows that as the Sasobit® content was increased, the softening point of mix also increased. Which is an indication that when Sasobit is mixed with bitumen, the effect of temperature changeon it will be minimal as Sasobit content increases (Mat et al., 2014). A mix ratio value of 1.8 % was therefore used for the asphaltic concrete mix. This value falls within the range of 0.8 – 4 %, usually adopted (Hurley and Prowell, 2011).

Table 1 Penetration index of Sasobit modified bitumen

Percetage of Sasobit	Penetration Test (mm)	Softening Point (°C)
0	64	47
1	55	50
1.5	50	59
2.0	47	64
2.5	40	68.5
3.0	38	72.5

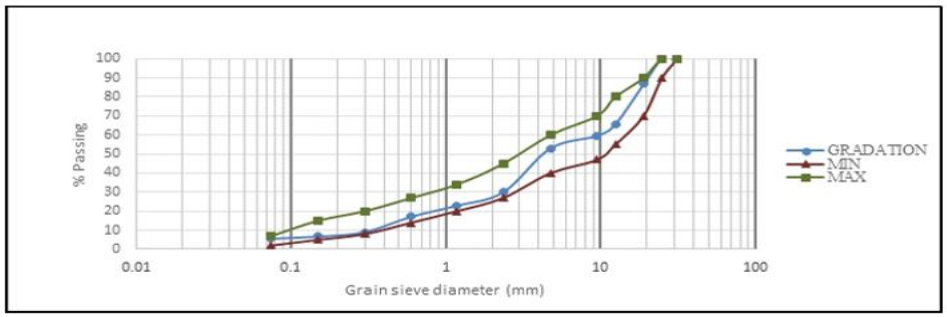

Fig. 2. Mix Design Aggregate Grading

Table 2: Marshal Mix Design Properties

S/N	Properties	Optimum Values	FMW&H Specification
1	Binder Content (%)	5.3	4.5-6.5
	Stability Test (kN)	13.83	-
2	Flow Test (mm)	2.97	2-6
3	Voids in Total MixTest (%)		
4	VFB Test (%)	4.8	3-8
5			
		67.2	65-72

VFB –Voids Filled with Bitumen

Table 3: Marshal Test Properties

S/N	**Properties**	**Mix without Sasobit**	**Mix with Sasobit**
1	Stability Test (Kn)	13.83	14.72
2	Flow Test (mm)	2.97	2.51
3	Specific Gravity	2.53	2.58
4	VFB Test (%)	64.87	73.80
5	VA Test (%)	4.34	3.99
6	VMA Test (%)	18.26	16.52

VFB-Voids Filled with Bitumen

VA- Air Voids

VMA- Voids in Mineral Aggregate

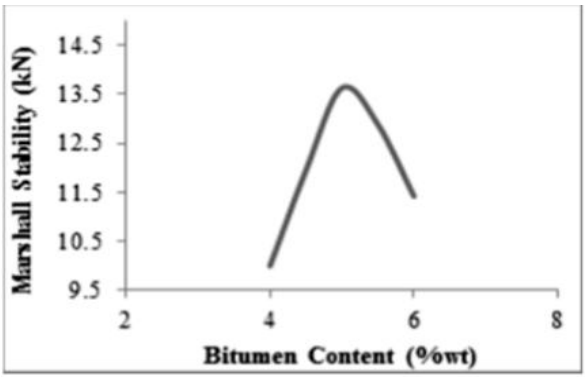

Fig. 3.Marshal Stability against Bitumen Content

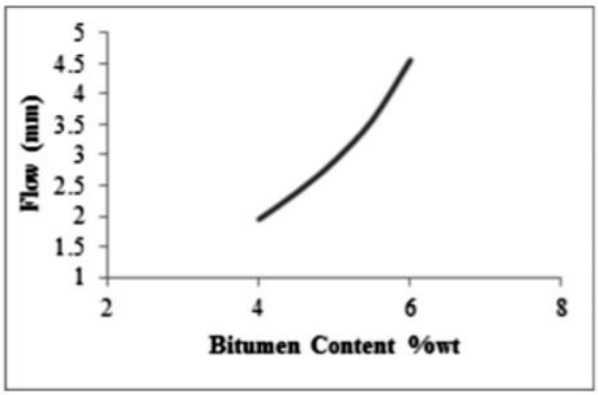

Fig. 4. Flow against Bitumen Content

When Sasobit was added, the Stability property was improved upon significantly, indicating higher strength of the mixes with Sasobit® and therefore, better structural integrity (Kurtis, 2013). The lower flow value shows that the thickness of the binder was lowered, meaning that the mixing and compaction temperatures was loweredor reduced as well, improved mix workability, increased resistance to rutting as well as better elasticity of the pavement. Better flexible mix was achieved in the mix with Sasobit because the binder content increased as shown in the result of Voids Filled with Bitumen (VFB), which is higher. While, the Air voids (VA) and voids in mineral aggregate (VMA) values that are lower in the Sasobit® mix; implies that the mix would be impermeable, if the mix is well compacted.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The research found the following values of bitumen with Sasobit and bitumen without sasobit to be; stability was 14.72, flow was 2.51, specific density was 2.58, voids filled with bitumen was 73.80, air voids was 3.99 and voids filled in the mineral aggregates was 16.52. And for sample without Sasobit® were 13.83kN 2.97 mm, specific density was 2.53, voids filled with bitumen was 64.87 %, air voids was 4.34 % and voids filled with mineral aggregates was found to be 18.26 %, respectively. The study concluded based on the resultsobtained that, Sasobit® as an additive in asphaltic concrete has the potential to improve its properties, and that the addition of Sasobitto bitumen has the potential to lower the penetration grade and cause the softening point of bitumen to be higher.

B. RECOMMENDATIONS

It is therefore recommended that Sasobit should be added to the 60/70 penetration grade bitumen that is most commonly used for road construction in Nigeria in order for it to be able to provide more resistance to permanent deformation and cracking. Especially as temperature in Nigeria is hot, and that is the main reason the environmental condition in Nigeria calls for a more viscous binder.

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